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ABSTRACT

A persistent increase in student, faculty, and administrative demand for information technology has resulted in a sharp rise in the total cost of computing services to universities. In response, universities must develop long-term strategic planning processes and policies to establish priorities for information technology investments, determine known costs and cost trends, and prepare budget alternatives that provide the flexibility necessary to respond to the rapid pace of technological change. A financial growth model that depicts typical growth patterns in the demand for information technology funding and establishes its general cost structure and its changes over time may be used to suggest how cost control measures can be identified and structured into the funding process. Three readily identifiable funding sources to consider are tuition, external funds, and internal operating budget reallocations; a fourth option, revenues from the sale or licensing of software products and electronic information services, is unlikely to produce significant income. Strategic planning of this nature will allow the university community to realize the goal of self-sustaining academic computing. Graphic representations of the funding model are included, and sources are identified in nine references. (KM)

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This article outlines a funding model and proposes funding sources for universities attempting to develop and control computational environments It proposes a growth paradigm that allows for the necessary, inevitable expansion of information technology in some university environments and suggests restraints on the potential for uncontrolled growth latent in all environments. Several points that support conceptualization of this paradigm stand out. The costs of technology have dramatically increased. It is prudent that universities accept and manage this reality on the basis of a desired outcome rather than by reactive, impromptu response.

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Funding models for information technology in higher education

Ronald L. Orcutt, Associate Director, Harvard University Office for Information Technology

Universities that have made a strong commitment to electronic information resources and the use of computers in their academic and administrative environments encounter a curious dichotomy. Although competition in the computer industry and benefits of the experience curve have contributed to a steady decline in the unit costs associated with the purchase and maintenance of computers and related information systems, and will continue to do so, a persistent increase in student, faculty, and administrative demand for information technology has resulted in a sharp rise in the *total* cost of computing services to universities. This situation is unlikely to change in the near future.

At Harvard the cost of information technology is increasing by twenty-five percent each year. Some of this increase is accounted for by the difficulties and misjudgements that inevitably accompany management of novel ideas and innovative systems, but more is attributable to the level of success achieved in introducing information technology into academic environments. Many skeptics who formerly faced the silicon siren lashed to the main mast are now fervent supporters of the latest academic software applications and proselytizers for the pedagogical potential of emerging technologies.

This development raises an age-old spectre—a head with a vision of infinite possibilities attached to a body that is withering from decreasing availability of resources. Universities face a bottom-line question, and from debates over funding have emerged such significant questions as: Who is going to pay for the computer revolution on campus? How will these payments be apportioned among groups as diverse and traditionally independent as those in major American universities? How are costs determined in an academic setting? and Can academic computing be funded in such a way that it is self-sustaining? These questions and others deserve the immediate attention of university officials. It is my purpose here to suggest how a university might approach these issues and to offer models that might assist in the control of the costs of academic and administrative computing.

At Harvard, the cost of information technology is estimated to be increasing by twenty-five percent each year.

Financial issues that once seemed tangential to the philosophical debate over the appropriateness and feasibility of information technology in the academic environment now threaten the development and application of computerized systems whose very existence was not even imagined just a few years ago. These financial issues will exert a powerful influence over decisions that will not be limited in their impact to the actual costs of computers, but will extend to such areas as the structure of the teaching discipline, the meaning of academic freedom, the ultimate role of a university, and finally, the ethical consideration of equal access regardless of ability to pay. One can readily imagine the potential scope and volatility of debate over such issues.

Cost conceptualization and cost trends

It can be argued that the greatest challenge will be not a logistical or financial but a conceptual one. We do not, in fact, yet know the full potential of electronic resources in a robust educational environment. Nonetheless, we must proceed to develop a common language to describe information technology in an academic environment and we must arrive at a consensus as to the costs of this technology, not only in terms of physical equipment and maintenance, but also in terms of opportunities gained, lost, or postponed.

Academic communities are not the first to confront the impact of information technology on an organizational system and its values. The rapid conception, implementation, growth, and (recent) demise of corporate management information systems departments are cycles that

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are probably endemic to any attempt to exploit the promise of information technology. For-profit corporations are unlikely role models for universities, but the business approach to cost analysis, the implementation of technologies, and the organizational response to economic necessity may offer valuable insights for developing methodologies for decision-making that, although conducted in a scholarly atmosphere, must still reflect the constraints of financial reality.

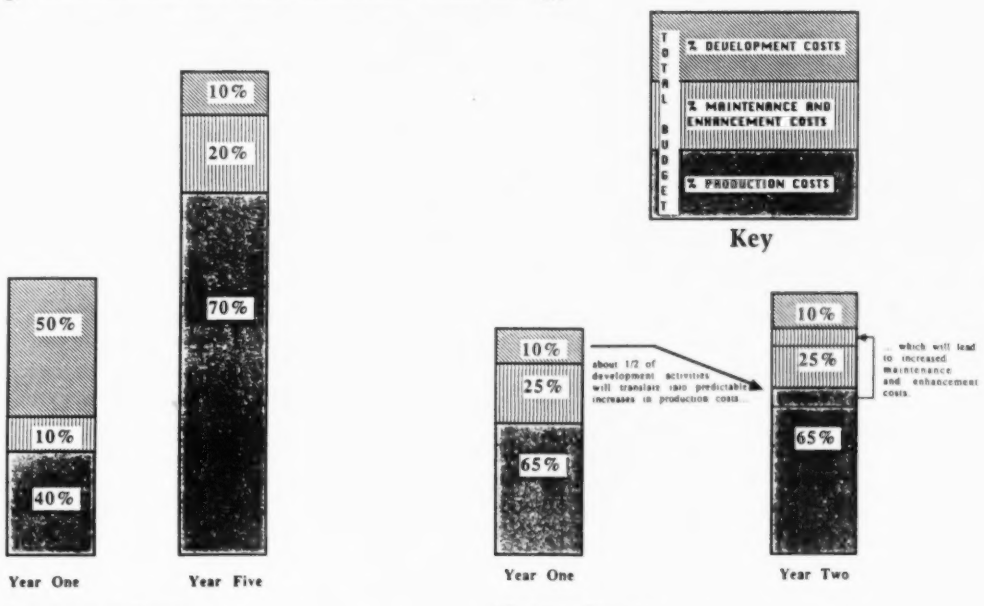
Information technology brings the issue of the capitalization of education into sharp focus. Universities must develop long term strategic planning processes, and policies to support these processes, if they are to establish priorities for information technology investments, determine known costs and cost trends, and prepare budget alternatives that provide the flexibility necessary to respond to the rapid pace of technological change. It is an unfortunate fact that most universities and their constituent departments have no clear idea of the amounts or functions of funds allocated for computing. Even when cost analysis and control systems are in effect, costs are not always appropriately defined or delineated. Universities are also uniquely vulnerable to miscalculations that can arise from the availability of inexpensive student labor and its impact on the determination of true costs of projects. In other situations, such vast sums are spent on hardware purchases that none are left over for software and technical support services vital to optimum system utilization. Overspending for equipment and the resultant unanticipated increase in future costs for support, maintenance, and future development are, in fact, symptomatic of an immature approach to the effective management of information technology.

At least one cost trend is taking a positive direction; hardware costs have undergone a steady decline that seems destined to continue. This decline in unit costs, combined with increasing capabilities of hardware and software, can be expected to continue across a spectrum of equipment. Minicomputers now do what only mainframes could do before, and capabilities of the personal computer grow, with each generation satisfying a broader range of user demands. These are positive developments, but they are *not* solutions to the funding problem. In fact, these trends have actually exacerbated the funding problem by increasing the rate of demand to the point that it counteracts unit-cost reductions.

Salary costs associated with computing are increasing more rapidly than the norm and have become the single largest element in the cost of technology, further straining funding sources. Very likely, the level of commitment or lack thereof to these expensive support and software areas will determine which institutions succeed with the implementation of information technology and which fail. Equipment grants from vendors will not help. By the most conservative measures, universities that have reaped substantial benefits from joint-development grants with vendors devote dollar for dollar amounts from their own operating budgets to these projects. Vendor grants and joint-study projects are the single biggest threat to a university seeking to restrict diversion of resources to technology.

Cost conceptualization in the fast-paced world of information technology is a process made difficult by

Funding Allocations for Information Technology



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some of the problems previously mentioned. The basic goals associated with, and potential applications of, electronic resources in an academic environment have begun to receive serious attention from university officials. But the rate of change in technology that is rendering equipment obsolete at an unprecedented rate greatly complicates long term planning efforts, and a lingering notion that computerization is threatening is harbored by enough academics in enough disciplines to make university consensus, always a fractious affair, nearly impossible. It is necessary that a clear vision of what a university expects from information technology be developed and a highly visible role for senior university officials in the achievement of these goals be evolved through a gradual process of consensus testing and reaffirmation. Initial efforts to establish formal goals, timetables, and agreement on substantive issues will produce enormous returns through a reduction of the potential for unrestrained cost growth relative to computers and electronic resources.

Industry has faced the challenges of information technology and its role in competitive survival before us. We can look to the procedural mistakes made by corporations to shed some light on the problems in cost analysis and budget allocation that we are facing now. Decisions relative to strategic uses of information technology, cost ingredients of equipment, software, and maintenance, determination of present and future costs, and methods of cost control are as relevant for academia as they are for industry. That excessive initial investments in hardware such as have plagued many a corporation are being perpetuated at our best academic institutions suggests that, at least thus far, we are more disposed to emulate industry's mistakes than to learn from them[1].

The two sections that follow describe a model that depicts typical growth patterns in the demand for information technology funding, establishes the general cost structure of information technology and its changes over time, and suggests how cost control measures can be identified and structured into the funding process.

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Growth paradigms

There is a need to distinguish patterns of growth in demands made upon the fiscal process by information technology. Environments in which electronic resources have been introduced in a significant way always experience a dramatic increase in funding demands for equipment and services. This characteristic readily appears in the academic and administrative environments of universities where information itself is at the very core of the university's *modus operandi* and constitutes an integral part of the "business" of the intellectual community. Because information pervades all aspects of academic life, the revolution in information technology portends explosive change in our universities. As the number of students, faculty, and administrators aware of the benefits (and perhaps the necessity) of information technology grows, so too does the demand for software, hardware, peripheral equipment, database access, telecommunications, support services, etc. These areas of demand include the development of new applications that will significantly enhance the computational environment.

This explosive growth is normal, but at the same time it is almost universally underestimated. It is essential for university officials to establish management techniques that control the inherent, explosive tendency of these areas of high growth without totally stifling them. Significant, controlled growth will assure technological development in a vital, rational manner that does not jeopardize the fiscal balance of the university.

Other areas of explosive growth in demand for equipment and service represent different situations that require university officials to admit that not every operation of the university needs or deserves funding at high-growth levels. This recognition must be accompanied by strict management techniques that contain growth in these situations, if it is allowed at all, at lower levels than in the areas allowed significant growth. The overall aim here is to foster stable, essentially static, computing environments with minor growth activity in which costs and cost trends are contained within predetermined amounts over long periods of time. Hospitals and other institutions that face spiraling costs and rigorous budget restraints have already recognized and benefited from this distinction.

These benefits will only obtain, however, if the strategic planning process of the university defines the areas most relevant to its historic role and future vision, and limits the allocation of ample growth funds to these critical areas. There has to be a funding balance between what might best be described as controlled growth in areas where the university perceives significant gain from satisfying demand, and controlled restraint in areas of demand that, although they also tend toward explosive growth, must, for strategic reasons, be constrained. Thus far, this has not proved an easy task for the majority of universities.

A funding model

The following graphs illustrate a financial growth model that offers one way to characterize the funding of technology in large systems. Although usually applied to business environments, an interesting and useful application of this model can be made to academic sectors. The model shows funding allocations in a start-up and a mature environment and how these affect

the development and production stages of information technology. The balance among these activity expenditures (or money uses) will determine the ability or inability to fund technology along sound strategic and fiscal principles. The three major elements in each model are: 1) *development* (the creation of new systems, or major changes in existing systems), 2) *maintenance* (the support and routine enhancement of existing systems), and 3) *production* (the operations and on-going use of systems already developed and in place).

The first stage, in which development receives excessive initial investment, presents an allocation imbalance typical of many environments first introduced to information technology; if unchanged, it guarantees that there will be disruption in the development of needed or desired applications and considerable dissatisfaction among university users.

In the beginning, large sums are mandated for development. When the results of these development efforts are translated into production activity, production costs (and the costs of maintenance and support) rise to meet the established applications. This shift in funding demand usually means that development allocations, coming under strict budget constraints, are reduced or frozen in order to cover production costs. Thus, future applications development suffers, and once this lag occurs it sets in motion a cycle of imbalance that is difficult (and expensive) to correct. This "immature" stage is illustrated in the figure so labelled.

Immaturity is as natural a period in the development of organizations as it is in organisms. It is a thing not to be avoided, but rather outgrown, as in the wild, as quickly as possible. To languor too long in immaturity can be as disastrous for organizational computing as it can be for organisms. The objective for both should be to reach a mature stage as quickly as possible and in organizational computing this entails recognizing the immature stage, being aware that there is a mature stage, and devising a plan to get from the former to the latter.

The financial growth stage illustrated in the "mature" figure depicts a more desirable allocation balance that achieves controlled growth. In a mature computing environment development proceeds continuously at a relatively constant rate, and the drop-down ratio from development to production costs is stabilized at fifty percent—in other words, one-half of the yearly development activities will translate into relatively predictable increases in production costs. The ratio of maintenance and enhancement costs is also stabilized, at around forty percent.

Stabilization and maximum returns from development funding occur only when a university sets strategic priorities, determines which goals will receive funding growth, and then sets management systems in place to oversee and evaluate the growth process. In the mature stage, this rate of growth for information technology expenditures typically averages fifteen to twenty percent each year.

Funding sources

The funding needs and resources available for information technology within any one university will vary according to that university's financial situation and the strategic goals it has established for itself. Leaders in the implementation and development of academic computing environments at Carnegie-Mellon University, Brown University, and the Massachusetts Institute of Technology have made plans to invest some two hundred million dollars over the next few years in various computing projects[2]. The rationale for the dedication of such enormous sums and the potential uses of computer technology in academic environments have already received considerable attention and will not be further examined here[3].

Every project, the establishment of a university-wide network of computer workstations (now under development at such universities as Brown, Wisconsin, and Stanford), or electronic integration of library systems (the HOLLIS project at Harvard[4]), has the potential to conjure up myriad, contingent opportunities and subsystems. Unlike traditional projects for which unambiguous beginnings and ends are identified, many information technology projects are open-ended, with no prescribed finish. This characteristic emphasizes the need for institutional management, and project evaluation in terms of strategic goals.

There are at present three readily identifiable sources of funding for university development of information technology: 1) tuition, 2) external funds (industry and government grants, subsidies, gifts, etc.), and 3) internal operating-budget reallocations. All three sources will have to be drawn upon for the creation of a successful computing environment in a university. A fourth source, revenues from the sale or licensing of software products and electronic information services, for reasons discussed below, is unlikely to produce significant income for universities. Each of these options has its own benefits and drawbacks.

1. Tuition

Charges to students have been on a steady rise in recent years and the use of computers on campus will put further pressure on this unfortunate trend. Computing will bring a broad range of benefits, in terms of added value and increased efficiency in education, but it will cost more, not less. It is widely predicted that costs for computing will eventually equal levels now expended on library resources.

Tuition increases to cover these funding demands may be necessary, but there exists an alternative possibility of direct charges, on a fee-for-service basis, for access to university networks, databases, printing, support services, etc. Also, students might be required (as they are at the Harvard Business School) to purchase their own computers when they enter the university. This approach, however, raises the issue of equipment compatibility, and further, the possibility that only those who can afford it will be granted access to sophisticated electronic resources. How will these exigencies be balanced with the university's historic commitment to the widest and freest possible dissemination of knowledge?

2. External funds

Many see this pillar of traditional funding (especially for university research facilities) as the obvious solution to the universities fiscal bind. Brown University, for example, recently inaugurated a partnership with International Business Machines Corporation (IBM) with an estimated dollar value to Brown of about fifteen million dollars over a three year period. This will be the largest single corporate partnership in Brown's history and will involve both a grant and a joint-venture. The Massachusetts Institute of Technology has won commitment of some fifty million dollars in equipment, staff, maintenance, and other support to Project Athena, a "major Institute-wide experiment on the integration of modern computer and communication capabilities into all phases of the educational process[5]." Digital Equipment Corporation (DEC), and again, IBM, are the corporations involved.

Sums of this magnitude might seem capable of solving any imaginable funding inadequacy. One crucial aspect of these corporate-university programs, however, that is too often ignored is that the universities themselves are committed to providing enormous sums of money for the projects on an ongoing basis, sums that equal, and often exceed, the size of the initial corporate grant. The MIT administration, for example, has launched a campaign to raise twenty million dollars for the support of Project Athena. Brown's electronic campus communication system will be implemented at an estimated cost of fifty-to-seventy million dollars. Brown officials stress that the money will be raised from sources other than current operating expenses, and that fund raising for all other needs will continue. William Shipp, associate provost for computing, observes: "There are times when money is available for some things and not for others. There isn't any real answer to that. As a University, we have to take advantage of the opportunities[6]." Needless to say, this pragmatic attitude is not just a reflection of the optimism necessary for a project of such enormity, it also reflects a conscious strategic-management decision concerning the university's goals and priorities.

Perhaps the most important point to be stressed in the entire discussion of funding sources and models for university computing is that it is desirable for an institution to evaluate its educational goals and the benefits it expects from technology before *embarking on what is going to be an extremely expensive undertaking.*

In a situation where funds are finite, every use mandates a use forsworn elsewhere. Grants are never "free" gifts. One large university that received an eight million dollar grant in equipment realized that its support and maintenance would require five million dollars out of the university's operating budget *each year.* Thus, external funding from vendors is not a solution to the problems posed by information technology costs. It is certainly an opportunity, but one that inevitably introduces the need for yet more funds (either for equipment or development) because it always accelerates the demand for electronic services. External grants for information technology do not reduce university costs, nor do they balance budgets; they are always accompanied by opportunity costs and further demands upon the university funding process.

3. Budget reallocations

This approach offers solutions that are no less volatile and complicated. At present, a situation has evolved in which university budgets contain money allocations for technology that are separate from allocations for other, traditional needs. The cost of technology, however, is an ever present one that continues to grow. James Johnson, Vice-Chancellor for Computing at the University of Houston, has estimated that expenditures now contemplated for information technology (and his estimate only includes basic hardware and software costs) amount to ten or fifteen percent of the total institutional budget[7]. This is not an insignificant amount of money. In addition, it represents new money, and it doesn't include the funds necessary to revamp administrative data processing—the movement from manual systems to on-line databases that encourages cost-effective access to information. It is clear that expenses of this magnitude will not be covered by accounting sleight of hand.

One way to deal with this growth is to trade off money formerly spent on other things, that is, budget reallocation. Any reallocation plan, however, must be evaluated as to the uses of the sources of funding. Internal reallocation means that someone, somewhere, loses a share. More money for computing means less money for plant upkeep, or scholarships, or faculty salaries, and so forth. These decisions, when made wisely, will reflect an overall strategic plan and not an ad hoc response. In many cases, the most readily available reliable funding source is budget reallocation. Indeed, many suggest that a plan that does not include significant budget reallocation is totally flawed.

Some have suggested a two-tier approach to faculty salaries—one level for the humanities, and another, higher level for the hard sciences; but once again the tenability and equity of this solution seems such that its adoption will create more problems that it solves.

More recently, another solution has begun to receive widespread consideration. It involves a complete analysis of a university's total computing costs and the establishment of a base figure that covers benefits provided to the entire academic community and for which there are no individual departmental or program charges[8]. All expenses that individuals or departments incur for services above this base level are treated as incremental and discretionary, and precise charges, in dollar amounts, are made for them. In addition to the control features and equity of this approach,

it has the further benefits of stimulating a comprehensive and strategic approach to the use of computing and of avoiding separate or dual systems for the university's administrative and academic functions. A base level figure also creates an awareness of what a university expects from computing and what limits it might wish to enforce.

Perhaps the most important point to be stressed in the entire discussion of funding sources and models for university computing is that it is desirable for an institution to focus on and determine its educational goals and the important benefits it expects to receive from technology *before* embarking on what is going to be an extremely expensive undertaking, and essential that this be done at some point. This challenge to the university requires the active support and involvement of the institution's top officials and the mechanisms to achieve the consensus of the entire academic community.

4. Software and electronic services revenues

There are fundamental differences between the business goals of software vendors for increased corporate revenues through software sales, and the university's goal of improved pedagogical products and methods and widespread dissemination of knowledge. There are, however, ways to resolve the incompatibility of these interests.

It has been suggested that universities develop their own software products and derive revenues from their sale, either to other universities or on the general market. This strategy must overcome several significant obstacles. First, the market for educational software has remained small. Universities, like other institutions, buy generic software products and adapt them. Discipline- or course-specific software satisfying the standards of one university or even one faculty member may not be acceptable to another. Second, the educational market is highly fragmented. Discipline- or course-specific software faces commercial restraints from such fragmentation, as well as from the absence of an effective national distribution system. Further, there are no generally accepted development procedures and standards for academic software. Even more importantly, very few faculty members (the most reasonable source of software development) are given the incentives, financial or otherwise, to develop software products or to share them once developed.

Universities must recognize these problems and increase their efforts to provide the necessary market concentration and program incentives for faculty-developed software, for example, royalty arrangements, staff support, peer recognition, tenure reward, etc. It will also be important to organize collectively and create an information exchange system that makes products known, develops standards, facilitates marketing, and sponsors marketing agents[9].

Site licensing

Site licensing of software, while not a source of funding, can provide some cost reductions. A university can, for example, reduce its purchase costs for software by negotiating the right to reproduce certain quantities of software programs at no (or nominal) incremental cost. This approach can satisfy both the corporate need for market presence and reasonable return on investment and the university's need to make computing widely available and sustainable. Site licensing arrangements, however, raise many complicated issues for universities with regard to free dissemination of research derived from proprietary software products, confidentiality of design features of software systems that may be exposed to competitors, restrictions on product modification, etc. These legal and ethical concerns make it imperative that universities compose and review software and equipment contracts with corporations with utmost care.

The goal of all such efforts, however, must be stated in clear terms. Academic software is costly to develop and hard to sell, and its development and dissemination (at least initially) must arise from a desire for the potentially immense pedagogical benefits that it offers and not for the unlikely realization of sizeable revenues to support university computing environments.

Paradise regained

Creation of a technologically rich environment on university campuses brings as many challenges as rewards, many of which are perhaps not yet even known. What *is* known, however, is that the social and cultural impact of the electronic revolution will bring changes as profound as those inaugurated by the industrial revolution two centuries ago. The advent of global communications networks and artificial intelligence software, the manipulation of enormous amounts of data at incredible speeds, and the prowess of other electronic resources are no longer probabilities; they are realities that will continue to alter our ways of thinking and living.

Information and its role in the development of knowledge and meaning is at the heart of every university's purpose. Universities must consider the overall scope of information technology and devise strategic responses to its inevitable influence on educational, research, and administrative environments.

Strategic management and goal formulation to support both the educational process and the broader leadership role of universities are fundamental prerequisites. The issues go far beyond the immediate questions of cost, efficiency, and resource allocation. The universities that have leveraged their costs and benefited from this process have understood that their educational goals depend upon the wise use of new technologies. They have understood costs and accepted risks in exchange for well conceived and broadly supported goals and institutional benefits. They have a vision of what is desired from information technology, and they are aware of the profound demographic changes taking place in the American student population. Their response to information technology is also a response to their competitors.

It is time to transcend the notion that technology is simply a cost like any other to be managed. Leadership and its rewards will fall to those who

Tradition and recent trends in debt financing at Harvard

Throughout its history most capital assets of Harvard University have been funded on a pay as you go basis. New construction was normally funded by gifts from generous donors. Equipment was funded by gifts, grants, and operations. If funds were not available, projects were usually postponed.

In the early 1970s universities became eligible to borrow money through public authorities at tax-exempt rates. Harvard decided to borrow money at these favorable rates to finance some long standing needs of the University that were not particularly attractive to donors—parking facilities and housing. The Everett Street and Broadway Street garages and the Soldier's Field Park complex were financed with tax-exempt debt.

In the late 1970s it became obvious that major renovations were required to University facilities. Some of Harvard's housing, laboratories, and classrooms were in poor condition. The old pay as you go system could not be relied upon without serious risk to the quality of education. At the same time the planned financing of the Medical Area Total Energy Plant fell through as construction was delayed and costs escalated. The University decided to borrow the funds for these important projects, and tax-exempt bonds provided financing at the lowest possible cost.

The *1984-85 Financial Report* highlighted the University's capital plans for the five years 1986-1990. Harvard expects to spend almost $500 million during the period, $350 million of which will be spent on renovations. Debt will provide $120 million of the $500 million required. No one likes to be in debt, but debt has made it possible for Harvard to integrate long range financial plans with operating budgets without delaying major renovations.

Thomas O'Brien
Financial Vice President
Harvard University

create an approach that responds to student and faculty demands for pedagogical creativity, research capability, and administrative efficiency, and allows information technology to provide the strategic advantage that is the foundation for future growth. Not all universities will or should respond to the electronic revolution in the same way, but it is safe to say that they all must fashion a response or be left behind by students and faculty who will go elsewhere.

Islands of technology no longer suffice; our goal, to provide an integrated, technologically rich environment, must be continental in scope. If we are to realize self-sustaining academic computing, all elements of the university community will have to accept its potential and present a unified front to the strategic management and funding challenges that it presents.

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